an infecting chancre at a very early period of its existence does not prevent secondary symptoms, and hence that the system must be regarded as infected from the very first. In other infectious diseases, as vaccinia, glanders, etc., the absorption of the virus is instantaneous, and analogy would lead us to infer the same to be true of syphilitic virus. But although this argument from analogy is of very considerable weight, it is not conclusive, and the question can only be settled by facts. From cases recorded it must at the least be concluded that destructive cauterization *a few hours after the development of the chancre* has failed to avert constitutional infection, and that the abortive method cannot be relied upon.

In the chapter on General Syphilis, the question of the contagiousness of certain secondary symptoms will be found most ably discussed. The amount of evidence now brought forth to prove their contagiousness is so great that it can scarcely be doubted any longer; and we are ourselves as fully convinced of the transmission under certain circumstances of infection from a secondary sore as of any other fact in medicine.[1] Whether derived from a primary or secondary symptom, syphilis pursues essentially the same course; in the latter case, as in the former, the initial lesion is a chancre.

We heartily congratulate the profession on the possession of this treatise on venereal diseases, and we would also earnestly urge all practitioners, for their own pleasure and profit, and, more than this, for the great benefit of their patients, to avail themselves of the opportunity thus offered of making themselves acquainted with the important facts recently discovered in regard to the pathology and treatment of these affections. A very wise man who wrote nearly three centuries ago tells us that it is of great importance to have regard to the age in which one writes—"*il importe beaucoup de regarder en quel age on escrit.*"

The writer of the volume to which we have just called attention has the rare advantage of having acted in accordance with this advice in every respect; his work is fully up to the advanced stage of our science, and it is likewise the work which was most needed at the present time by the profession.

In the getting up of this volume the publishers have made the best use of the great facilities at their command, and have omitted nothing in the way of paper, letterpress, or illustrations, that could add to its appearance or its usefulness.   W. F. A.

ART. XII.—*A Course of Lectures on the Physiology and Pathology of the Central Nervous System.* Delivered at the Royal College of Surgeons of England, in May, 1858. By C. E. BROWN-SÉQUARD, M. D., F. R. S. Philadelphia: J. B. Lippincott & Co., 1860.

THE indefatigable and restless industry of Dr. Brown-Séquard has, from time to time, added many curious facts to our stock of knowledge, with regard to the functions of the nervous system. Beyond question, the most important of these acquisitions, which we owe to his genius and skill, are the discoveries which relate to the *transmission of the sensitive impressions*

[1] In the last number of this Journal is contained a very conclusive case of the kind, related by Dr. Clements, U. S. A.

in the spinal cord. These impressions were almost universally admitted, for a long period of years, to be transmitted by the fibrous texture of the posterior columns. The double function of the cord, as an organ of transmission, was thus thought to be precisely similar to that of the two roots of the spinal nerves. As the anterior roots of the spinal nerves were demonstrated to be the organs of transmission for the motor stimulus, and the posterior roots for the sensitive impressions, so the anterior columns of the cord were regarded as the exclusive channels by which the motor stimulus was conveyed downward from the brain, and the posterior columns as the only means of communication by which sensations found their way upward to the sensorium. It was natural, accordingly, to consider the spinal cord, at least so far as concerned the white substance of its anterior and posterior columns, as nothing more than a bundle of fibres continuous with those of the nerve-roots; giving off, from time to time, motor fibres to the anterior roots, and receiving, from time to time, sensitive fibres from the posterior roots.

An anatomical analogy was also found to exist between the anterior and posterior columns, in regard to the lateral decussation of their fibres. It had long been shown, beyond a doubt, that this decussation, for the anterior columns, must be located at the lower part of the medulla oblongata in front; the whole of the motor fibres of the right anterior column passing through the left side of the medulla oblongata, to the left side of the brain, and the whole of those belonging to the left anterior column passing through the right side of the medulla oblongata, to the right side of the brain. A similar decussation for the fibres of the posterior columns was pointed out, by various observers, at the upper part of the medulla oblongata, behind.

The physiological and pathological proofs of the locality of this decussation, however, were much less complete for the posterior columns than for the anterior. It was easily demonstrated that injury of one side of the brain produced paralysis, both of motion and of sensation, on the opposite side of the body; so that no doubt could exist of the complete decussation of both sets of fibres. But for the motor fibres of the anterior columns the precise spot of this decussation was indicated by the result of physiological experiment as well as by the researches of the anatomist. For while injury of the brain, as above mentioned, was always found to produce a paralysis of motion on the opposite side of the body, injury to the *spinal cord itself* on one side was followed by paralysis on the same side. Up to the level of the medulla oblongata, therefore, the motor fibres of the cord were shown to be in relation with the nerves and muscles of their own side of the body; above that level, with those of the opposite side. It seems to have been inferred a little too hastily that the arrangement of the sensitive fibres was a similar one, and that they all crossed over, from right to left and from left to right, at a single point, in the upper portion of the medulla oblongata, or just below the tubercula quadrigemina.

Dr. Brown-Séquard, however, has corrected this inference in a very important particular, by showing that the decussation of the sensitive fibres of the spinal cord takes place, not at a single point at or above the level of the medulla oblongata, but throughout the whole length, or nearly so, of its longitudinal extent.

The first experimental fact demonstrated by Dr. Brown-Séquard, in regard to this point, was a very unexpected one. He showed that if a complete sec-

tion were made, in the living animal, of one lateral half of the spinal cord, paralysis of motion resulted, as previously demonstrated, on the corresponding side of the body below the point of section; but so far from the power of sensation being lost in the same parts, the sensibility of the skin and subcutaneous tissues *was absolutely increased* on the corresponding side of the body. Further experiments indicated that the increase of sensibility under these circumstances was owing to an unnatural congestion of the parts following the section of the nervous fibres. But the most important fact thus ascertained was that section of one lateral half of the spinal cord does not destroy the sensibility of the parts below, on the corresponding side. The conducting fibres of the sensitive impressions do not, therefore, like those of the motor impulses, remain connected with the same lateral division of the spinal cord throughout their course.

This question was still further elucidated by Dr. Brown-Séquard, by an experiment consisting in the double section of the spinal cord at different points. He divided, for example, the right lateral half of the cord in the lower dorsal region, producing, as above, *hyperæsthesia* of the right posterior extremity; and afterward, on dividing the *left* lateral half of the cord, in the same animal, in the *cervical* region, he found that the right lower limb, previously hyperæsthetic, lost, in consequence of the latter section, all trace of sensibility in the integument and subcutaneous tissues. Thus both the negative and positive results of those experiments pointed to an entire decussation of the sensitive fibres in the spinal cord itself.

This result was rendered more striking by combining a section of both posterior columns of the cord with a complete section of one of its lateral halves. Both posterior columns, for example, having been divided, there is hyperæsthesia of all the parts behind the point of section. Subsequently the section of the entire lateral half on the right side being completed, the hyperæsthesia on the *right* side seems to be increased, while on the left side, all sensibility has disappeared.

By a combination of various other ingenious operations the experimenter perfected his demonstration still more thoroughly. Perhaps the most simple and at the same time most striking of these operations is that which consists in a *splitting*, or longitudinal division of the spinal cord upon the median line. The spinal cord is laid bare in the entire lumbar region, and throughout the whole of that portion which gives origin to the nerves of the posterior limbs, a careful section of the cord is performed, along the median line, so as not to injure the substance of either lateral half, but simply to divide the middle and commissural portion of the cord. This is, of course, an exceedingly delicate operation, and, as the author acknowledges, it is not possible to avoid entirely slight accidental injuries to one side or the other. It may be accomplished sufficiently well, however, as he says, to give very distinct and very important results. These results are that the *sensibility of both posterior extremities is entirely lost*, while their voluntary movements remain nearly unimpaired, thus demonstrating at the same time the decussation of the sensitive, and the non-decussation of the motor fibres in this part of the spinal cord.

This experiment, as Dr. Brown-Séquard states, was performed many years ago by Galen, who failed to notice, however, its curious effects upon the sensibility of the parts.

Dr. Brown-Séquard, however, is not content with showing the fact of the decussation of the sensitive fibres in the spinal cord. He endeavours

to establish the exact mode of this decussation and the entire route through which the sensitive impressions are conveyed upward to the brain.

In the course of his remarks on this question he takes occasion to discuss a very important point in regard to the proper mode of experimenting on the sensibility of the nervous system, and the conclusions to be drawn from certain results. This question is the following : *How are we to determine whether a particular part of the nervous system have or have not the power of transmitting sensitive impressions?* Dr. Brown-Séquard very properly remarks that certain experimenters have too readily taken it for granted that the true test for the existence of this power is the *sensibility or non-sensibility of the parts themselves.* They have supposed that a portion of the nervous apparatus which is itself sensitive must necessarily be the conductor of sensation from other parts; and, *vice versâ*, that a portion which is not sensitive cannot be a conductor of sensibility. They confound the two properties of transmission and sensibility, or regard them as necessarily coexistent.

Dr. Brown-Séquard, however, shows that there is no ground for such an assumption. The two properties mentioned above are quite distinct in their nature, and may exist separately or together, as the case may be. In point of fact, those parts of the nervous system which are sensitive, that is, in which painful or other sensations are excited by mechanical or galvanic irritation, are for the most part found to be also the conductors of sensibility; but the latter property is demonstrated by a different set of experiments from those which prove the existence of the former. We can ascertain whether a part be sensitive or not, by simply applying an appropriate cause of irritation, such as the galvanic current, and seeing whether a painful sensation be manifested in consequence. But in order to decide whether a part be the conductor of sensitive impressions from other organs, it is necessary to apply the irritation to these other organs, and to see whether its transmission to the sensorium be affected by the injury or division of the part under examination.

If this rule of investigation be applied, as Dr. Brown-Séquard contends, several parts of the nervous system, which are not themselves sensitive to external irritation, will be found to be undoubtedly the organs of transmission from other parts ; since, if they be injured or destroyed, the parts below will be found to have lost their sensibility. This mode of experimenting becomes particularly valuable when it is claimed that such or such a part is the *exclusive* channel of transmission for nervous impressions. If the claim be a just one, the sensibility of the organs below must be *entirely* abolished by destruction of that part alone, the remaining connections being left untouched; and furthermore the transmission of sensations must remain perfect, provided that particular part be untouched notwithstanding all the other connections be entirely cut off.

Dr. Brown-Sequard does not believe that the posterior columns of the spinal cord are the exclusive channels for the transmission of sensitive impressions; and he thinks that this property has been too hastily attributed to them on account of their sensibility to external irritation—a sensibility similar to that possessed by the posterior roots of the spinal nerves, and which is not to be found in the anterior columns of the cord, nor in the anterior roots of the spinal nerves.

The author even seems to doubt the fact that the posterior columns of the cord possess so great an amount of sensibility as has been attributed to them. He thinks that this apparent sensibility has been exaggerated from

two causes: first, that a galvanic shock applied to the posterior columns must necessarily irritate at the same time the posterior roots of the corresponding nerves, so that the sensibility of the nerve-roots, which is very acute, has been mistaken for that of the columns, which is doubtful: and, secondly, that irritation of the posterior columns gives rise very readily to *reflex movements*, which have sometimes been mistaken for signs of pain. Even in the decapitated animal, as the author states, the reflex movements excited by irritating the posterior roots of the spinal nerves, at the same time with the posterior columns, are much more decided than when the irritation is applied to the posterior columns alone.

We do not think, however, that the author is quite right in attributing the usually received doctrine in regard to the posterior columns as organs of transmission, altogether to their supposed sensibility to direct irritation. This remark is particularly applicable to what is said of Longet on page 15.

"Mr. Longet," it is said, "thinks that the gray matter of the spinal cord cannot be a conductor of sensitive impressions, because it is not endowed with sensibility; and his single argument to prove that the posterior columns are the sole conductors of the sensitive impressions is that they are the only sensitive parts of the spinal cord."

Longet, in reality, adduces another, and, if we are to trust his results, extremely important observation bearing on this point.   He says (*Traité de Physiologie*, vol. ii., part ii., p. 187):—

"Some physiologists having considered the gray substance of the cord as indispensable to the transmission, not only of sensitive impressions (Bellingeri), but also of the principal of the voluntary movements (Van Deen, Stilling, &c.), we would here say that, in the dog, we have constantly found the gray matter at the same time destitute of sensibility and incapable of exciting convulsive movements under the influence of electricity and mechanical irritations; *and that its destruction, to as great an extent as possible, by means of a stilet, has not been found to modify, in any way, either the sensibility of the posterior columns or the excitability of the anterior.*"

But whatever is to be thought of Longet's experiments on this point, and the value of his mode of operating, there is no doubt that Dr. Brown-Séquard has pointed out, in a very effective manner, the full requirements of the question at issue, and the danger of trusting too much to results obtained from direct irritation applied to the posterior columns themselves.

By his own experiments also he has shown very strong reasons for the belief that the posterior columns of the cord, though they receive the posterior roots of the spinal nerves, do not exclusively transmit their sensitive impressions to the sensorium above.

We have already alluded to the singular hyperæsthesia which he has found to result from section of the posterior columns.

"The first fact," he says (p. 19), "I have to speak of is, that a transversal section of the posterior columns, instead of being followed by the loss, or even a diminution of sensibility, seems to produce an increase in the amount of this property; in other words, I have found that the section of these pretended only channels of the sensitive impressions, instead of preventing them from passing, allows them, on the contrary, to pass more freely, so that instead of *anæsthesia* there is *hyperæsthesia*.   In certain animals, and especially in rabbits and sheep, it is easy to ascertain that there is a very great increase in sensibility in the various parts behind the section.   Before the operation, in rabbits, the most energetic pinching of the skin produces agitation, but no shrieking; after the operation, on the contrary, the least pinching produces shrieking and a much greater agitation.   Sometimes the hyperæsthesia is so considerable that the

least pressure upon the skin makes the animal shriek. Whether the operation is performed in the lumbar, the dorsal, or the cervical region, the phenomena are always the same; that is, there is a manifest hyperæsthesia in the various parts of the body which receive their nerves from the part of the spinal cord which is behind the section. It has been so in all the animals I have operated upon, and I have already made this experiment upon animals belonging to more than twenty species.

As long as the animals live, after the section of the posterior columns, hyperæsthesia continues to exist, except in cases where reunion takes place between the two surfaces of the section; but hyperæsthesia is greater during the first week after the operation, than it is after a month or many months."

      *   *   *   *   *   *   *

"If we carefully dissect the two restiform bodies, so as to separate them from the neighbouring parts, and if we divide them transversely at their two extremities and then remove them, we find that the animal, instead of losing its sensibility in the different parts of the limbs and trunk, becomes hyperæsthetic.

It results, from these experiments, that the restiform bodies, which are the direct continuations of the posterior columns of the spinal cord, are not the only channels for the transmission of sensitive impressions to the sensorium.

It seems certain, therefore, *that the posterior columns of the spinal cord and of the medulla oblongata are not the only channels for the transmission of the sensitive impressions from the limbs and trunk to the sensorium.*"

Dr. Brown-Séquard, however, arrives, by further experiments, to much more complete results than the foregoing; for he finds that after dividing by a transversal section, the whole of the spinal cord, *with the exception of the posterior columns,* sensibility is lost altogether in the parts situated behind the point of division. The sensitive impressions, therefore, in the natural condition of the parts, are *wholly* conveyed by some other route than that of the posterior columns. This route, the author believes, is an oblique one; the sensitive filaments, derived from the posterior nerve-roots, passing for a very short distance after their joining the spinal cord, by the corresponding posterior columns, and then entering the central gray matter of the cord, in which they afterward cross to the opposite side of the median line, thus giving rise to the decussation or crossed action of the spinal cord, in the transmission of sensitive impressions.

The difficulty in establishing this fact lies in the want of any sensibility as resident in the central gray matter. But this has already been shown to be no objection to the truth of the author's conclusions. The gray matter may have the power of transmitting nervous impressions from below, though it may not itself be sensitive to direct external irritation. It is not necessary to suppose that the same sensitive filaments, derived from the posterior nerve-roots, pass continuously through the gray matter of the cord to be afterward connected with the sensorium above. They may terminate in the substance of the gray matter, which is in its turn connected, by commissural longitudinal fibres, with the ganglia of the brain. This anatomical arrangement, in fact, has been heretofore suspected to exist, owing to the small size of the spinal cord at its upper portion, as compared with the immense number of filaments which it gives off below to the spinal nerves. It was thought that the cord could not, on account of this disparity in size, contain all the filaments derived from or given off to the anterior and posterior roots of the spinal nerves.

The author asserts the power of the central gray matter of the cord to transmit sensitive impressions, from the results of experiments quite different from those obtained by Longet, to which we have already alluded. Let us remember that division of the posterior columns of white matter alone

produces hyperæsthesia in the parts below, but no loss of sensibility; and that an increase of sensibility is also found to take place after division of the lateral columns. Now, Dr. Brown-Séquard finds that if a transversal section be made of the whole posterior half of the cord, in the dorsal region, so that, beside the posterior white columns and part of the lateral columns, a portion of the central gray matter is also divided, then there is a diminution of sensibility in the two posterior limbs. Since this diminution cannot have been caused by the division of the posterior or the lateral columns, it must have been owing to the partial section of the central gray matter.

Again, a similar section being made of the whole *anterior* half of the spinal cord, a similar partial loss of sensibility is found to take place in the posterior limbs, which cannot be the result of the injury to either the anterior or lateral white columns, and must therefore, as before, be attributed to the partial section of the central gray matter.

It will be seen that these experiments on the effects of section of the central gray matter are essentially the same with those performed by Longet, but yielding diametrically opposite results. Longet endeavoured to destroy the central gray matter of the spinal cord by the use of a stilet introduced longitudinally, leaving the white columns untouched; while Brown-Séquard divides successively the anterior and posterior halves of the gray matter, together with their corresponding columns of white substance, having previously ascertained that division of the white columns alone will not produce a loss of sensibility. We do not undertake to decide to what cause the discrepancy between the two is to be attributed.

The oblique course of the sensitive fibres, after their entering the spinal cord from the posterior roots of the nerves, is shown by successive sections of the posterior columns and of the gray matter. The author finds that, if the posterior columns of the cord be divided a very short distance above the point where they are joined by the posterior roots, these roots lose their sensibility—showing that, for this distance, it is transmitted by the posterior columns. If the section of the columns be made a little higher up, the sensibility of the posterior roots is diminished, but not destroyed—showing that at that point some of the sensitive fibres have left the posterior column to reach another part of the cord; and if higher still, the sensibility of the posterior roots remains unaffected, because all their filaments have now left the posterior columns, after passing for a time obliquely through their substance. But if the central gray matter of the cord be divided at this last point, according to Dr. Brown-Séquard, the sensibility of the posterior roots immediately disappears, since their organ of transmission has been destroyed.

It is by a combination of many ingenious experiments similar to those which we have quoted above, that the author fortifies his position, and makes it, at least, in the highest degree probable that the transmission of sensitive impressions in the spinal cord takes place by a continuous and oblique decussation, and through the substance of the central gray matter.

The first four lectures are occupied with the discussion of the above questions. Lectures 5th to 8th inclusive contain various conclusions of a similar nature deduced from pathological cases, which the author studies and records in close connection with his experimental observations. Among these are cases of alteration of the whole spinal cord with preservation of sensibility; cases of alteration of the gray matter alone, with loss of sensibility and voluntary movements; cases proving that the decussation of the

channels of sensibility takes place in the spinal cord, and not in the medulla oblongata ; cases of loss of voluntary movements in one side of the body, and of sensibility in the opposite side ; paralysis due to disease of the gray matter; anæsthesia without paralysis, &c. &c.

The author recognizes very fully the complete distinction between the different kinds of sensibility—as, for example, sensibility to pain, to tactile impressions, to the effect of tickling, and to variations in temperature. It has been now for a long time known that these sensations are not the same in kind, but must be regarded as dependent upon quite distinct impressions upon the nervous system ; for the sensibility to pain may be quite acute when that of ordinary touch is dull, and *vice versâ*.   In fact, a painful impression, whenever it exists, actually interferes with the healthy appreciation of the qualities of foreign bodies by the sense of touch ; and when the contact of a foreign body, by the suddenness or violence of its application or by the intensity of heat or cold, becomes painful, we can no longer perceive with any distinctness its true physical properties, but only the suffering which it produces.

Dr. Brown-Séquard has been led to believe that these different kinds of sensibility are not only distinct in their nature, but are actually *transmitted to the sensorium by different channels in the nervous system.*   He does not, in the present work, give all the reasons which have led him to adopt this view, but he gives in the eighth chapter an analysis of certain cases of alteration in the spinal cord which go to show the probability of there being in this organ a special place of passage for some of these peculiar impressions.   He believes that they all pass, however, by different channels through the gray matter of the cord.

These are :   Cases of the loss of tactile sensibility, of the power of feeling pinching and pricking, and of the muscular sense, with persistence of the power of feeling cold and tickling.   Loss of the power of feeling tickling or the simple contact of foreign bodies, with persistence of the sensibility to pain.   Loss of tactile sensibility, with increased sensibility to painful impressions.   Loss of the power of feeling heat, while tactile sensibility remains.

The ninth chapter is occupied with the sympathetic nerve and the effects of its division and galvanization on the circulation and state of sensibility in the parts beyond.   It is well known that Dr. Brown-Séquard attributes all the results of this nature following division or irritation of the sympathetic nerve, to a temporary paralysis or contraction of the bloodvessels, and consequent change in the supply of blood circulating in the capillaries. This chapter, however, is more particularly of interest here, as being introductory to the succeeding one, in which the author speaks at length of the different kinds of reflex action as influencing, respectively, muscular contraction, the flow of the secretions, and the nutrition of the tissues.   In each of these cases the reflex influence may be either positive or negative in its results—may produce either an increase or a diminution in the activity of the part.   Thus we may have, in the case of the muscular system, either a reflex convulsion or a reflex paralysis.   Reflex paralysis, in fact, is a subject which the author has made peculiarly his own, not only by bringing out distinctly the fact of its existence, but also by pointing out its different varieties, and by indicating the leading peculiarities of its treatment, as distinguished from that of ordinary or *direct* paralysis. In the same connection he speaks of the sudden arrest of the heart's movements, which sometimes takes place by a reflex action—the cause of

rapid death after injuries of the abdominal sympathetic nerve—stoppage of the heart's movements by the application of cold to the skin, by the influence of cold drinks, and in some cases of death by chloroform—muscular atrophy due to an irritation of sensitive nerves, &c. &c. This entire subject of the various reflex influences at work both in the healthy and pathological conditions of the system forms an exceedingly varied and interesting topic for investigation. It has grown wonderfully since the first experiments were performed upon the reflex convulsive movements in the voluntary muscles due to irritation of the skin in a decapitated frog. It has been shown, in fact, to enter more or less fully into nearly all the functions of the living body, those of growth and nutrition as well as those of sensation and muscular activity. No one, it may fairly be said, has followed out this subject so fully, or pursued it so successfully into its varied ramifications, as the author of the present work.

The eleventh chapter is devoted to a subject closely connected with the preceding and naturally following upon it, but which is still more peculiarly the scientific property of Dr. Brown-Séquard, *i. e.*, the *artificial production of epilepsy in the lower animals.* One of the most curious results ever attained by experimenting upon the nervous system was that which excited the attention of the profession some years ago, when our author brought out his unexpected discovery that a convulsive affection, closely resembling if not identical with epilepsy, might be produced in the guinea-pig, in consequence of a mechanical injury to the spinal cord, usually in the dorsal or lumbar region. A few weeks after the injury of the spinal cord, and when the immediate effects of the operation have much diminished or have passed away altogether, epileptiform convulsions appear, and are repeated daily, or once in two or three days. But the most important peculiarity of the convulsions, in this connection, is that they can be excited at will by pinching or otherwise irritating a particular point of the skin, situated over the angle of the lower jaw. No other part of the integument, according to the author, is capable of exciting these convulsions on being irritated, and the irritation of this point is almost invariably followed by a fit, so long as the affection continues. Dr. Brown-Séquard has frequently demonstrated these curious facts, since their discovery, to the students and medical men who have attended his various courses.

The epilepsy in these animals is, therefore, a *reflex* convulsion; and the author, in applying the results of the experiment to pathological conditions, treats of epilepsy in general as a reflex affection, depending, very probably, in the first instance, on some injury or disease of the spinal cord, and afterwards excited, so far as regards each particular attack, by an impression produced upon the integument or some part of the mucous membranes. It is unnecessary to point out the extremely interesting nature of these hints on the nature and mode of access of epileptiform attacks, or the valuable suggestions as to treatment which may be derived from them. They are very fully followed out, in this and the following chapters, and will abundantly repay perusal, both in a practical and scientific point of view.

We are inclined to believe that the present volume will be found to be the most valuable and successful which has yet emanated from the fertile pen of Dr. Brown-Séquard.   J. C. D.